MONITOR Control Room Support Contract

Ramp Meter Retiming Procedure

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Section 1 – Ramp Meter Retiming Introduction

Section 1.1 – Purpose of Report

The Ramp Meter Retiming Procedure has been developed for the Wisconsin Department of Transportation's Traffic Operations Center. The document is intended to guide an engineer and/or operator through developing timings for a new ramp meter or retiming existing ramp meters. The document is considered a "living" document and will require modifications as the ramp meter retiming process is refined, amended, or changed.

Section 1.2 – Purpose of Ramp Meters

Ramp meters are traffic signals on freeway entrance ramps that break up clusters, or platoons of vehicles entering the freeway, thus making merging safer. Ramp meters can also store and spread out the volume of vehicles entering the freeway over time so it is less likely to become congested and the overall rate of travel is minimally affected. Ramp meters are the most effective means of managing freeway traffic congestion and optimizing travel times.

Section 1.3 – Need for Ramp Meter Retiming

Ramp meters discharge vehicles based on freeway conditions. Freeway volume, speed, and occupancy can change from day to day and over the course of time. As time goes by, the amount of traffic using the freeway system can increase causing slower speeds and more congestion. Therefore, it is necessary to retime ramp meters annually. Ramp meters also need to be retimed during construction projects. There may be a need to extend the metering times due to lane closures or set the ramp to meter in a fixed plan if mainline freeway loops are damaged due to construction.

Current freeway traffic information is used to develop ramp meter operating times and discharge rates. In order to retime the ramp meters annually, a technician is required at approximately 10 hours/week and an engineer at approximately 2 hours per week. The 2002-2003 ramp meter retiming schedule is included in Appendix A.

Section 1.4 – Ramp Meter Policies

WisDOT, District 2, has outlined a policy for ramp metering. A Ramp Metering Policies Manual will be completed in February 2003.

Section 2 – Ramp Meter Definitions & General Concepts

Section 2.1 – Ramp Meter Definitions

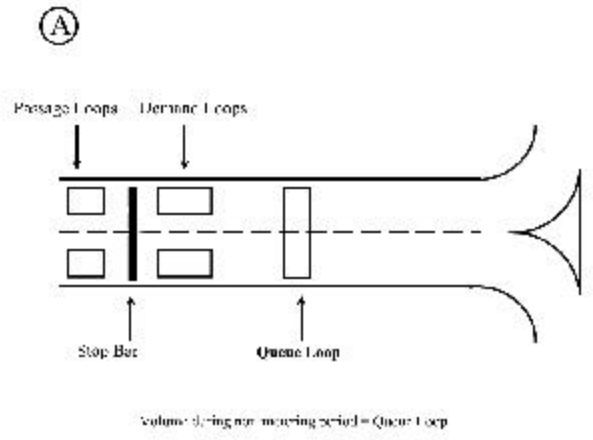
Detector Loops – Ramp meters have a variety of detector loops associated with them. Generally, the Freeway mainline loops have two loops assigned to each lane, a primary and secondary loop. This combination is known as a trap. Freeway on-ramps have the following loops: freeway mainline, queue, demand, passage, merge, exit, and reporting-only loops. Newer ramps also have merge loops. A loop detector diagram is included in Appendix B.

Freeway Mainline Loops - Volume, speed, and occupancy data is retrieved from the freeway mainline loops. These loops are also used for adjusting signal rates according to flow characteristics on the mainline. The primary loops are always used and are typically displayed as Ln 1 Primary, Ln 2 Primary, etc.

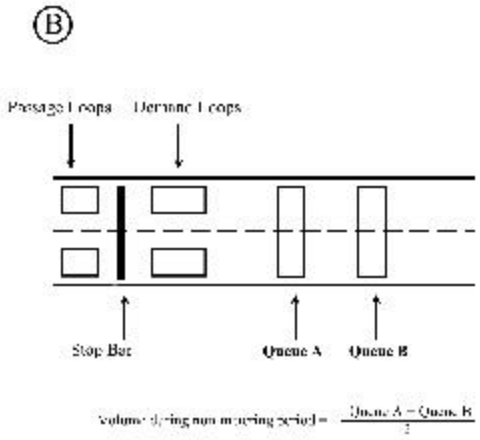
Merge Loop – If an on-ramp has a merge loop, it should be used for determining ramp volume. The merge loop is located near the end of the ramp, close to the point that the ramp merges with the freeway.

Queue Loops – When a merge loop doesn't exist, queue loops are used for determining the volume of the on-ramp during non-metering periods. The number and location of queue loops varies per ramp, so the ramp volume is determined as described below:

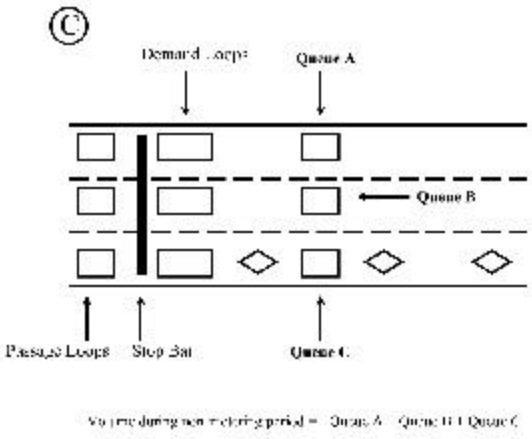
A) When ramps have 1 queue loop that extends across the entire ramp, this loop is used to determine the ramp volume.



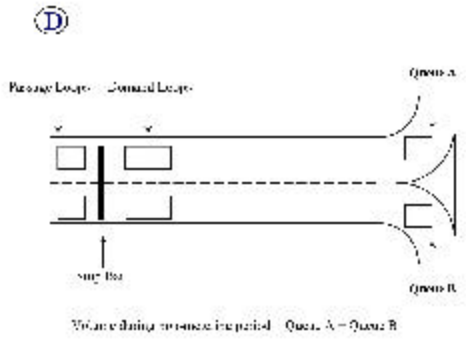
B) When queue loops are located in the middle of the ramp, and extend across all lanes, the loops should be averaged to determine the ramp volume.



C) When there is a queue loop for each lane on the ramp, the ramp volume is determined by summing the loops.



D) When queue loops are located at the entrance to the ramp, the ramp volume is calculated by summing the loops.



Queue loop data is also utilized in calculating the queue occupancy threshold for ramp metering.

Demand Loops – Demand loops are located prior to the stop bar. These loops detect the presence of a vehicle at the stop bar and trigger the signal to turn green to discharge the vehicle. The demand loops are not used in the ramp meter retiming process.

Passage Loops – Passage loops are located just past the stop bar. These loops sense when the vehicle has moved beyond the stop bar and trigger the signal to turn back to red. They are used to determine the volume on the ramp, during metering periods, when a merge loop doesn't exist. The volume is calculated by summing the passage loops.

Loops Reporting-Only – Some ramps have loops that are located at the entrance to ramp that are "reporting only". These loops may be used to determine the turning volumes onto the ramp or summed to determine the volume on the on-ramp, as described in scenario D under "Queue Loops." These loops can be used when queue and passage loops are not feasible. Reporting-Only loops are also located on off-ramps and can be used to determine the volume of vehicles on the off-ramp.

Ramp Meter Discharge

Single Discharge – The ramp has one lane so it is discharged alone.

Simultaneous Discharge – When a ramp has 2 lanes, the meter discharges 2 vehicles at the same time.

Duel (or Staggered) Discharge – When a ramp has 2 or more lanes, the meter discharges vehicles one at a time.

HOV Lane Discharge – When a ramp has 2 SOV (single occupancy vehicle) lanes and 1 HOV (high occupancy vehicle) lane, the HOV lane is discharged by use of a Programmable Logic Unit (PLU). The controller has the limited capability of metering 2 lanes, so the PLU is used to discharge the HOV lane. The HOV lane is typically released within a couple seconds of the furthest SOV lane.

Ramp Meter Plan Operations

Traffic Responsive – The ramp meter operates based on the local freeway traffic conditions.

Fixed Plan – The ramp meter operates in a plan that is designated by the engineer or operator. The cycle length of the ramp meter will remain consistent based on the timings selected by the engineer or operator. Ramp meters operate in a fixed plan when mainline or ramp loops do not exist or when they are in need of repair.

Must/May – The must/may plan allows the ramp meter to initiate metering prior to the user defined start time if the freeway thresholds are met. It will also allow the ramp meter to shut off earlier if the thresholds are not being met. It is typical to define a must/may period 15-30 minutes prior to ramp meter initiation and 15-30 minutes prior to metering termination.

Section 2.2 – Ramp Meter Concepts

Ramp Meter Operations – Ramp meters can be set to operate in a fixed plan or as traffic responsive. Most of the ramp meters in the system operate as traffic responsive and require the user to enter timings and thresholds for each of the 6 plans.

Ramp Meter Interval Timings – The user must enter timings for each plan, with Plan 6 being most restrictive. Plan 1 is generally used for queue flush, or discharging vehicles as quickly as possible when the ramp is severely backed up. Ramps should generally operate in a Plan 3 or 4. The minimum and maximum red time varies depending on the type of discharge and are as follows:

Minimum Red Times –

- Duel Discharge = 1.8 seconds
- Simultaneous Discharge or Single Lane = 2.5 seconds

Maximum Red Times –

- Duel Discharge = 8 seconds
- Simultaneous Discharge or Single Lane = 10 seconds

It should be noted that there are certain ramps that require the minimum red time to be less than 1.8 seconds. Ramps that have excessive volume and/or minimal storage length have a tendency to back-up onto the side streets if the red time is as great as 1.8 seconds. Therefore, the user must decrease the red time in order prevent severe back-ups.

Ramp Meter Thresholds – The user must enter the freeway lane volume, percent occupancy (percent of time vehicles are occupying the loop in a 20 second period), and speed thresholds for each of the 6 plans. Archived data from the mainline loops is used to develop the thresholds. Queue override thresholds must also be entered and are determined from a series of calculations of ramp queue loops.

Ramp meters can operate in a fixed plan when mainline or ramp loops do not exist, or when they are in need of repair. The user must develop red and green times for the designated operating plan and values for the queue override thresholds. The queue override function will override the fixed plan if the ramp backs up.
Freeway volume, occupancy, and speed thresholds are not required.

Ramp Meter Periods – Ramp metering periods are determined by reviewing the volume to capacity (v/c) ratio of the freeway. Based on the

Highway Capacity Manual (HCM), congestion levels are critical when the v/c ratio reaches 0.7. Thus, It is common practice to begin metering when the freeway reaches a v/c ratio value of 0.7. The user must also consider freeway occupancy greater than 18%, freeway speed reduction, ramp volume, and downstream bottleneck conditions when determining ramp metering periods.

If the ramp meter is operating as traffic responsive, the user should define a must/may period of 15-30 minutes when the freeway v/c reaches 0.65. This allows the ramp meter to initiate metering slightly earlier if the thresholds are met. A must/may period is also used 15-30 minutes prior to terminating ramp metering.

In some locations it is undesirable to use the must/may periods. For instance, must/may periods should not be used for the ramp meters at I-94 EB from Barker Road/Hwy 18 (RM 63/64). The ramps are side-by-side and need to turn on and off at the same time in order to prevent driver confusion. By having a must/may period, the ramps can turn on and off at different times. Therefore, one ramp could be metering while the other ramp is not. There are additional locations that must/may periods should not be used. These locations vary on a case-by-case basis and should be determined by the ramp metering operations engineer.

Section 3 – Retiming Process

Section 3.1 – Introduction

Section 3 of the Ramp Meter Retiming Procedure is intended to guide the user through the retiming process. This section details the required steps in the order that they must be completed. The following list summarizes the procedure:

Step 1 (Section 3.2) – Collect Background Information
Step 2 (Section 3.3) – Ramp Meter Field Inspection
Step 3 (Section 3.4) – Data Collection and Data Validation
Step 4 (Section 3.5) – Ramp Meter Retiming Spreadsheet
Step 5 (Section 3.6) – Ramp Meter Timings Review and Acceptance
Step 6 (Section 3.7) – New Timings Entry Into 170 User Interface
Step 7 (Section 3.8) – Ramp Meter Observation
Step 8 (Section 3.9) – Documentation and Filing Documents

Section 3.2 – Collect Background Information

General
The first step in retiming a ramp meter is to collect background information on the ramp and ramp meter. The following historical information is needed in order to properly retime a ramp meter:

- Current design or as-built FTMS plan view sheets
- Current design or as-built pavement marking plan
- Current design or as-built signage plan
- Current timing plan (printout of 170 timings) if not a new ramp meter

Each ramp meter has a hanging folder located in the file cabinets on the east side of the building. The file cabinets make up the south wall as you enter the east side of the building, and have a “Ramp Meters” label on them. The above-mentioned plans can be found in the corresponding ramp meter folder. If the plans are missing, or are out-dated, then the person completing the ramp meter field visit is responsible for locating them. Current plans can be found in the TOC plan filing cabinets on the west side of the office. Copies of the plans must be placed in the ramp meter folder for future use.

If the user is developing timing plans for a new ramp meter, then a ramp meter folder must be made. The user must retrieve the current plans from the TOC plan filing cabinets and make copies of the FTMS, Pavement Marking, and Signage plans.

Section 3.3 – Ramp Meter Field Inspection

General

A ramp meter field visit should be conducted prior to retiming a ramp meter. The inspection is done in order to ensure proper ramp meter operations, detect and report any maintenance needs, and validate signing and pavement marking. The inspection must take place during the AM or PM ramp metering period and requires a minimum of 15 minutes of observation.

The user should take a blank Ramp Meter Field Inspection Report (Appendix C) with them to the field. The user should also make copies of the FTMS, Pavement Marking, and Signage plans and always return the original set to the file. The copies should be taken to the field and notes can be written on them if necessary.

The completed Ramp Meter Field Inspection Report, with copies of plans attached, should be given to the current staff member responsible for ramp meter operations. The form will then be reviewed and any further needed action will be taken and documented. The responsible party will then sign, date, and file the form.

Completion of Ramp Meter Field Inspection Report

A blank Ramp Meter Field Inspection Report is located in Appendix C and is also available at *W:\RM's\Ramp Meter Retiming\RM Field Inspection Report*. The inspector must complete the form during the ramp meter field visit. Note that if the △ shape is marked on the form, then comments are required on the lines provided below that section. Detailed descriptions of the content of the report are included in the following pages.

Ramp Meter (General Information) Section

The form requires documentation of the name of the inspector, ramp meter number and ramp location. The date, time, weather condition, and pavement condition must also be noted.

Configuration – Record the number of Single Occupancy Vehicle (SOV) lanes. Also document whether a High Occupancy Vehicle (HOV) lane is present.

Discharge – Observe the ramp meter to determine the type of discharge for the SOV lanes:

- Single Discharge - ramp has one lane so vehicles are discharged alone
- Simultaneous Discharge – ramp has 2 SOV lanes and vehicles are released at the same time
- Duel Discharge – ramp has 2 SOV lanes and vehicles are released one at a time

If there is an HOV lane, the discharge type must also be recorded as:

- Steady Green – the HOV lane has a steady green signal
- Discharge with Adjacent Lane – the HOV lane discharges at the same time as the lane directly next to it
- Discharge with Far Lane – in cases where there are 2 SOV lanes, the HOV lane discharges at the same time as the far SOV lane
- Discharge Alone – the HOV lane discharges alone; it does not discharge at the same time as the SOV lane(s)

Also observe the HOV lane for excessive violations and document on the inspection form.

Ramp and Freeway Conditions – Record the amount of vehicles waiting on the ramp to enter the freeway, also known as the queue on the ramp. Also observe the freeway and estimate the average travel speed and volume.

Signing

The current signing plans are needed to complete the signing section.

Ramp Metered When Flashing Signs – Ramp Metered When Flashing Signs are typically located at the entrance to the ramp. They may also be located on the side streets or on the ramp.

Review the signing plans and record the number of “Ramp Metered When Flashing” signs per the plans. Field verify that the signs are present and in the proper location. Also record the condition of the signs as good, damaged, turned, or obstructed. Use the comments section to record the location of the sign(s) if it is in poor condition.

Stop Here On Red Signs – Stop Here On Red Signs are located at the stop bar of the ramp.

Review the signing plans and record the number of “Stop Here On Red” signs per the plans. Field verify that the signs are present and in the proper location. Also record the condition of the signs as good, damaged, turned, or obstructed. Use the comments section to record the location of the sign(s) if it is in poor condition.

Lane Designation Signs – The Lane Designation Signs are located near the stop bar. They are either mounted on the signal poles on the left and right sides of the ramp, or are mounted on the overhead signal pole.

Review the signing plans and field verify that all lane designation signs are present and in good condition. Use the comments section to record the location of any signs that are missing, damaged, turned, or obstructed.

HOV Signs – HOV Signs can be located on the ramp, side streets, or both.

Review the signing plans and record the number of HOV signs per the plans. Field verify that the signs are present and in the proper location. Also record the condition of the signs as good, damaged, turned, or obstructed. Use the comments section to record the location of the sign(s) if it is in poor condition.

Signs on Side Streets – Review the signing plans and record the number of miscellaneous signs on the side streets. Field verify that the signs are present and in the proper location. Also record the condition of the signs as good, damaged, turned, or obstructed. Use the comments section to record the type and location of the sign(s) if it is in poor condition.

Pavement Markings

The current pavement marking plans are needed to complete the pavement markings section.

Review the plans and record any missing pavement markings. Also document the condition of the following pavement markings if applicable:

- Stop bar
- Edge lines
- Lane skips
- Median paint
- HOV lane designation symbols

Use the comments section to record the type of pavement marking if it is missing or faded.

Pavement Condition

Pavement Type and Condition – The form requires the inspector to note the ramp pavement type as concrete or asphalt, and rate the ramp pavement condition as new, good, fair, or poor. If the pavement condition is in fair or poor condition, the observations must be documented in the comments section.

Pavement Condition In Areas of Loop Detectors – The pavement condition in the areas of the loop detectors must also be recorded. The inspector must review the FTMS plan to identify the location of all loops on the ramp. Each loop must be inspected. If it is difficult to identify the location of the loop, then check the corresponding box. If the loop location is identifiable, the form instructs the inspector to look for depressed pavement around the loop, and cracks or deterioration in the area of the loops. If poor pavement conditions exist around a loop, then further documentation, including the loop type (queue, passage, demand, or merge), must be recorded in the comments section. Refer to the loop detector diagram in Appendix B.

Hardware

Signal Heads – The inspector must observe all of the signal heads to determine that they are working. The yellow signal head is lit *only* at the time of ramp meter start-up and must be observed at that time. If the inspector is unable to observe the ramp at the time of metering initiation, the “Not Inspected” box can be checked. However, this is not desirable.

Advanced Flashers – The “Ramp Metered When Flashing” signs have flashers mounted above and below them. The inspector must also document whether or not the flashers are working.

Cabinet

Cabinet Exterior – The exterior condition of the ramp meter cabinet must be examined during the field visit. The inspector should look for signs of graffiti, rust, water in or around the cabinet, and excessive weeds or tall grass around the cabinet. The inspector must also note whether or not the lock is easily accessible and works properly.

Cabinet Interior – The inspector must also observe the interior condition of the cabinet. The inspector should note whether or not the light is working and document any signs of pests. Photographs of cabinet are shown in the following pages. The cabinet consists of 3 sections:

1) The 170 Controller (upper section of the cabinet)
2) The Detector Amplifiers (middle section of the cabinet)
3) The Power Source (bottom section of the cabinet)

Interior of Cabinet

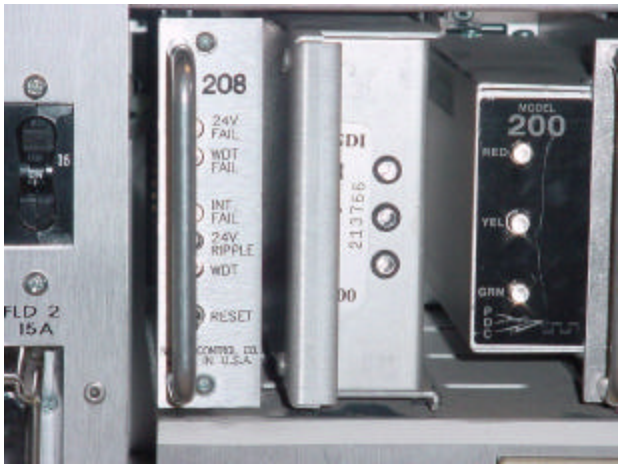
170 Controller
(upper section of cabinet)

Detectors Amplifiers
(middle section of cabinet)

Power Source
(bottom section of cabinet)

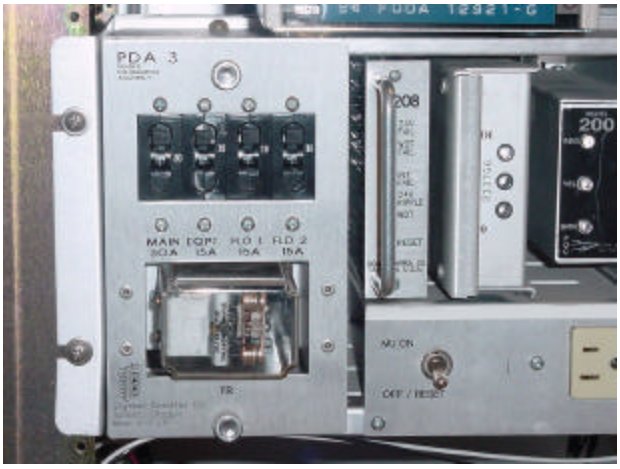
The following items in the controller cabinet should also be checked:

- Watchdog Failure (WDT Fail) – document if the controller is in watchdog failure. The controller is in watchdog failure when the red light is illuminated.



- MU toggle switch – record if the toggle switch is in the on or off/reset position.

- Circuit breakers – document any circuit breakers that are in the “off” position or any that appear to be missing.



- Detector Amplifiers – record any amplifiers that are pulled out of the controller. Also document if any detectors are in failure; detectors are in failure when the “FLT” (fault) light is illuminated, when the red LED light is constantly on, or if the light is not blinking when vehicles cross the loops.

Action Taken

The inspector shall follow the current “Equipment Malfunction Procedure” for required ramp meter maintenance. The “Equipment Malfunction Procedure” is included in Appendix D. The inspector must document the action taken in the section provided on the form and submit it to the current staff member responsible for ramp meter operations. The report will be reviewed, signed, dated, and filed in the appropriate ramp meter folder by the responsible party.

Documenting Pavement Repair and Pavement Marking Maintenance Needs

The inspector must document any pavement repair or pavement marking maintenance needs in the database at *W:\RM's\Misc\RM Repair Log*. The database will be used to develop contracts for refurbishment and placement of faded or missing items.

Follow Up

The inspector is also responsible for follow-up on the maintenance requests to ensure that the maintenance personnel address them.

Section 3.4 – Data Collection and Data Validation

General

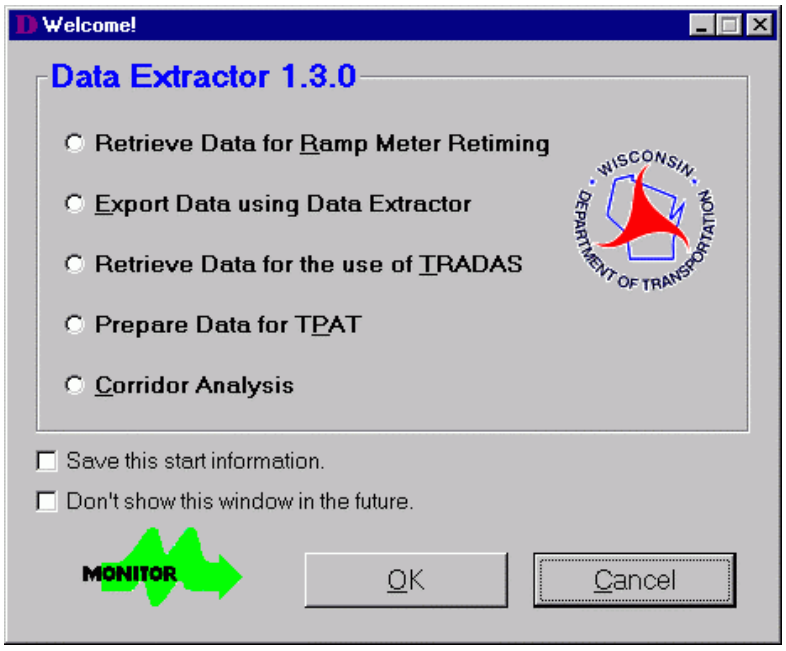
Once the field visit has been completed, data must be collected. Ramp meters are retimed based on current freeway traffic conditions. In order to get an account of current traffic conditions, archived data must be queried. A program called the Data Extractor was developed to enhance the collection of data for ramp meter retiming.

The Data Extractor software is available to all WisDOT staff and can be installed on any computer by talking with the TOC's IT Specialist. This section merely guides the user through the steps of collecting data for ramp metering. However, the user may reference the Ramp Meter Retiming Module User Manual, or HTML Help menu for a detailed explanation of the capabilities of the program.

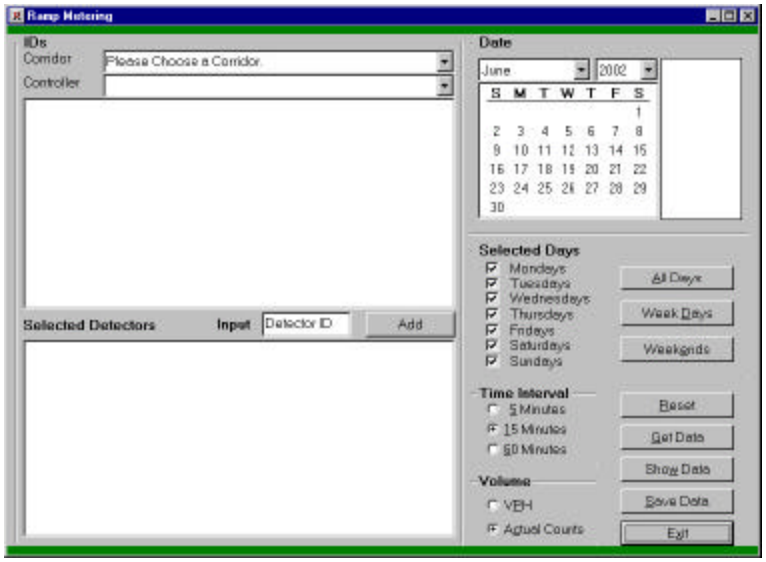
Procedure

Once the program is installed, it is opened by clicking on the Data Extractor icon:

When the Data Extractor is launched, the user should select "Retrieve Data for Ramp Meter Retiming" and click OK.



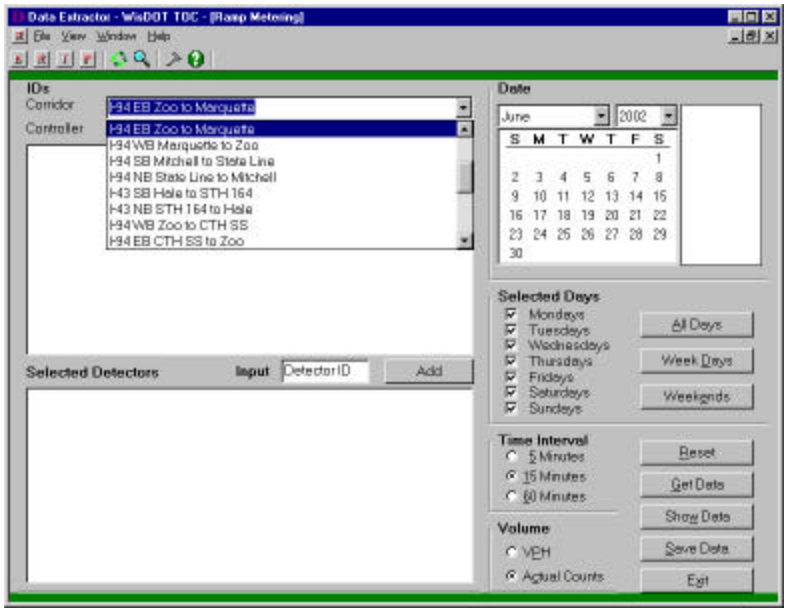
The Data Extractor introduction window, which is shown below, will appear:



The following steps should be followed in the retiming process:

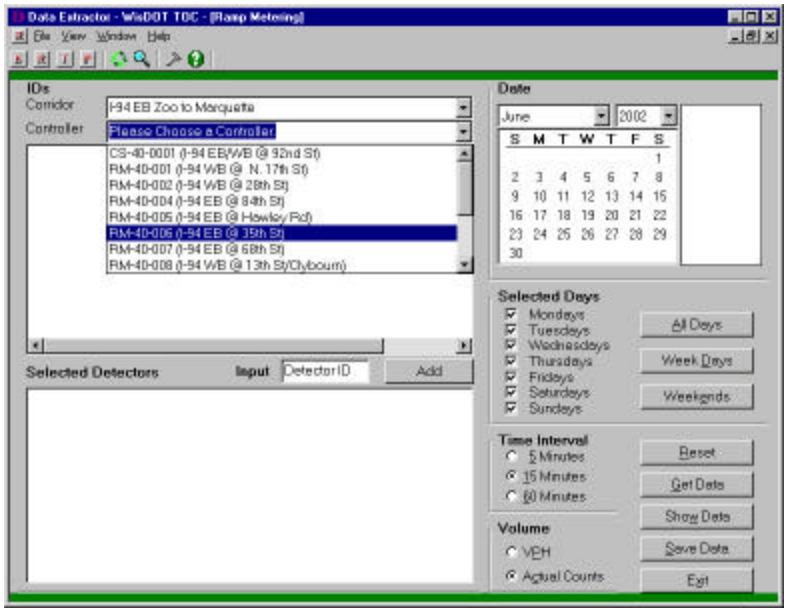
Step 1 – Corridor Selection

The user must select the desired corridor by highlighting the corridor from the corridor pull-down menu and left-clicking the mouse button.



Step 2 – Controller Selection

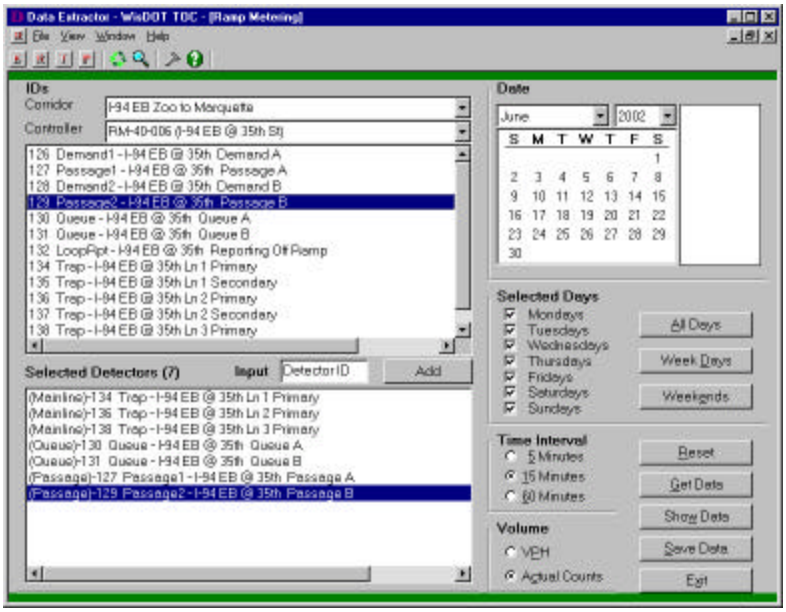
The user must select the desired controller by highlighting the controller from the controller pull-down menu and left-clicking the mouse button.



Step 3 - Detector Selection

Automatic Selection

The user must highlight the detector and double-click the left mouse button. The selected detector will appear in the bottom window of the user interface.



Manual Selection

The user can manually enter the detector number if it is known. The following procedure should be used:

- Enter the detector number in the box labeled “Detector ID”
- Press the “Add” button or press “Enter” to drop the detector into the window on the bottom of the page

The detector will be labeled as “General” so the user must select the appropriate detector type (i.e. mainline, queue, passage, or merge) by doing the following:

- Highlight the detector by clicking the left mouse button
- Press the right mouse button and a menu will appear
- Select the appropriate detector type

This process can be repeated to add more detectors.

Detector Deletion

A detector can be deleted by:

- Highlighting the detector by clicking the left mouse button
- Selecting the “Delete” key on the keyboard

Or

- Highlighting the detector by clicking the left mouse button
- Clicking the right mouse button
- Selecting “Delete” from menu

Or

- Highlighting the detector by clicking the left mouse button
- Double click the left mouse button

Step 4 – Date Selection

A maximum of 18 days of data can be collected for ramp meter retiming. The user should select dates that fall on a Tuesday, Wednesday, or Thursday and should always select 18 days. The user should also select dates from different months to reflect the traffic during the different seasons of the year. For instance, the user could select 3 days in January, March, May, July, September, and November to total 18 days. The user must also avoid selecting dates that are known holidays or special events, like Summerfest and State Fair. The user has the ability to select specific dates, which is generally used for ramp meter retiming purposes, or a range of dates as described and shown below.

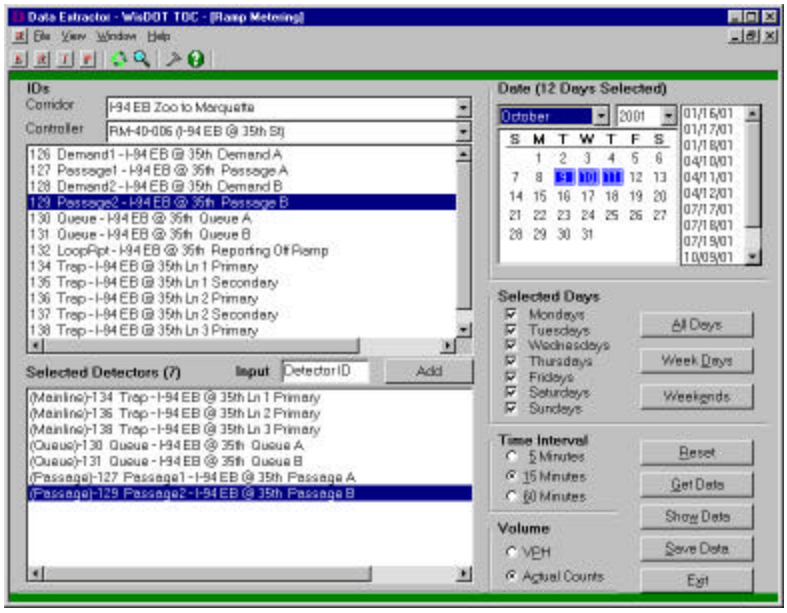
Specific Date

The date is selected by using the left mouse button to highlight the desired date. The selected date will appear in the window to right of the calendar. The month and year pull down menus allow the user to select dates from various months and years. The maximum number of days that can be selected is 18.

Range of Dates

A range of dates can be selected by highlighting the date at the beginning of the range and pressing the shift key while selecting the date at the end of the range. The month and year pull down menus allow the user to select dates from various months and years. The maximum number of days that can be selected is 18.

An entire month can also be selected by clicking on the right mouse button and choosing “Select All.”



Date Deletion

The date can be deleted by clicking the left mouse button on the highlighted date. Highlighting the date in the window to the right of the calendar, and hitting the delete key can also delete them. The user can also click the right mouse button and selecting "Clear Selection" to delete all the dates selected within that month.

Step 5 – Parameter Selection

Selected Days

If a range of dates is selected, the user has the ability to use the "All Days", "Week Days", or "Weekend" button. For instance, if the user selects dates for an entire month, but only wants to retrieve data for the weekdays, the "Week Days" button can be selected. The user may also select an entire month and select the "Weekends" button to retrieve data for the weekends only. This option would be used when developing timings for special ramp meter operations (i.e. construction timings, special events, etc.).

Time Interval

Archived data is available in 5-minute, 15-minute and 60-minute periods. The 15-minute time interval is currently the only option that can be used in ramp meter retiming, therefore it is the default on the user interface.

Volume

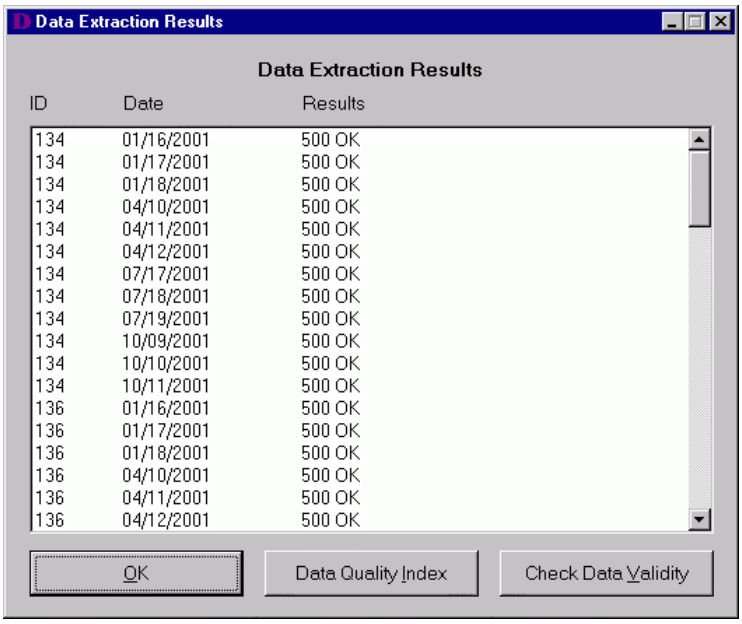
The volume can be retrieved in Vehicles Per Hour (VPH) or Actual Counts. Actual Counts are used in ramp meter retiming and is the default on the user interface.

Step 6 – Retrieve Data

The data is retrieved by selecting the "Get Data" button from the ramp metering window.

Step 7 – Data Validity Check

After the data is retrieved, a Data Extraction Results window will appear. The user may scroll through the window to ensure that the result of the inquiry reads "500 OK." The data retrieval was unsuccessful if an error message is displayed in the Data Extraction Results window. This window is shown on the following page.



For Ramp Meter Retiming purposes, the user must select the “Data Quality Index” button. This tool quickly scans the data for non-zero and non-repeating values and provides the user with a summary of the query. The results must be equal to or greater than the following:

90% volume counts are non-zero values
90% volume counts are non-repeating values
85% data has passed the prescreening tests

If the Data Quality Index results are less than the values above, then the user must select different days for data retrieval.

The user may also choose to select the “Check Data Validity” button to check the quality of the detector data. This step is optional but recommended, especially if the Data Quality Index summary indicates that the data is not acceptable. The user can use this tool to determine which day(s) have bad data. The user must reference the Data Validity Users Manual for further information on the data validity check.

The user may also select the “OK” button in order to return to the Ramp Metering Window.

Step 8 – Show Data

The user has the option of viewing the data in an excel spreadsheet before saving it. The purpose is to visually double-check the quality of the queried data. This is done by selecting the “Show Data” button from the ramp meter retiming user interface.

Step 9 – Save Data

The data is saved by selecting the “Save Data” button from the ramp meter retiming window. For all ramp meter retiming uses, the user should select “Save Into RM Retiming Excel Template.” This command will export the data into the ramp meter retiming workbook. A window will appear to prompt the user to save the data in the RM’s folder on the W drive. The user will then have to select the appropriate corridor and ramp meter folder. The file should be saved in the “Settings Development folder.”

After the data has been saved, the Data Extractor displays a screen that will allow the user to go directly to the ramp meter retiming workbook by clicking the “Yes” button.

The user also has the option of selecting the “Save As New Excel File” command. This will save the data in a new excel workbook and will not be linked to the ramp meter retiming workbook. This option would be used in cases that a quick query was made to view volumes, speeds, or to verify detector data.

Step 10 - Reset

The reset button can be selected to clear the entire user interface. A note of caution that selecting this button will delete all previous data entered into the user interface.

Step 11 – Exit

In order to proceed with ramp meter retiming, the user must exit the Data Extractor by selecting the “Exit” button. A window will appear on the screen to prompt you into the Excel spreadsheet. The program will open the ramp meter retiming workbook if “yes” is selected. The program will close if “no” is selected.

If the user does not want to continue with the retiming process, the user can close the Data Extractor by selecting “Exit” from the File pull-down menu.

Section 3.5 – Ramp Meter Retiming Workbook

General

Once the data has been saved in the Data Extractor, it is transferred into an Excel workbook that is formatted for ramp meter retiming. The Ramp Meter Retiming Workbook is comprised of spreadsheets that are utilized for data formatting and calculations. A list of the spreadsheets, and a brief description of each, is provided below:

- Mainline Data Sheet – The queried mainline volume, occupancy, and speed data is stored in this spreadsheet.
- Ramp Data Sheet – The queried ramp volume data is stored in this spreadsheet.
- Retime Sheet – The Retime spreadsheet contains many of the calculations for developing the suggested ramp meter threshold volumes and metering schedule.
- Input Sheet – The required input for ramp meter retiming is entered into this spreadsheet. This spreadsheet is explained in further detail throughout this section.
- 170 User Sheet – The suggested ramp meter timings and metering schedule are provided in this spreadsheet. Further explanation can be found throughout this section.
- Mainline V vs. C Plot Sheet – This graph presents the volume over capacity of the mainline.
- Mainline Average Occupancy Plot Sheet – This graph displays the average mainline occupancy over time.
- Ramp Volume Plot Sheet – This graph depicts the ramp volume over time as calculated by passage, merge, and queue loops.
- Mainline Speed Plot Sheet – This graph displays the average speed on the freeway at a given time.

Procedure

The user must first open the “Input” spreadsheet in the RM Retiming Excel Template. The user must enter the required input into the two sections included in the Input spreadsheet - the User Defined General Data Input and the User Defined Ramp Volume Determination. The user must then open the 170 User spreadsheet

to view the suggested ramp meter timings, thresholds, and schedules. These spreadsheets are described in detail in the following text.

Step 1 – Open Input Spreadsheet

Enter User Defined General Data Input

The user enters general freeway and ramp information into this section of the Input spreadsheet (Figure 1). The user must complete the shaded areas in order for the spreadsheet to perform the proper calculations. The data entry requirements are as follows:

General Information

RM I.D. Number – The ramp meter ID number must be entered.

- Example: RM-40-103 would be entered as RM 103

RM Location – The ramp meter location must be entered.

- Example: The location of RM 103 is US 45 SB @ Burleigh Street

Purpose – The user must enter the purpose for ramp meter retiming.

- If the ramp meter is being retimed for general purposes, like annual retiming efforts, the user would enter “G.”

- If the ramp meter is being retimed for freeway reconstruction purposes, the user would enter “C.”

Freeway Information

Number of Freeway lanes – The user must enter the number of freeway lanes as 2, 3, or 4. The number of lanes can be determined from the plans and/or from camera verification.

Peak Hour Factor – The default peak hour factor is 0.95. This number can range from 0.80 to 0.99, and if desired, the data can be obtained through the District 2 Technical Services Unit.

Percent Trucks – The default for percent trucks is 0.06, or 6%. This value can range from 3% to 10%, and if desired, the data can be obtained through the District 2 Technical Services Unit.

Freeway Terrain – The type of freeway terrain must be entered.

- Enter “L” for level terrain. The stretch of freeway along I-94 from Ryan Road to College Avenue is an example of “level terrain”.

- Enter “R” for rolling terrain. The stretch of freeway along US-45 from the Zoo Interchange to Burleigh Street is an example of “rolling terrain”.

- Enter “M” for mountainous terrain. The stretch of freeway along I-94 from STH 100 to Moorland Road is an example of “mountainous terrain”.

Freeway Posted Speed – Enter the posted freeway speed as 50, 55, or 65 miles per hour (mph).

Ramp Information

SOV Storage Length – The user must calculate the ramp storage length for entry into the spreadsheet. The ramp storage length is determined by measuring the length of the SOV lane(s) only. The storage length is the distance (in feet) measured from the stop bar to the point that vehicles can back up without:

1) Spilling onto the arterial or
2) Blocking vehicles from entering the HOV lane, if applicable.

Note that if the storage length is measured from a metric plan, the number must be converted to feet for entry into the spreadsheet. An example storage length measurement is shown in Appendix E.

Average Vehicle Length – The default average vehicle length is 20 feet. This number can range from 18 to 22 feet and should only be modified by an experienced user.

SOV Ramp Discharge Type – The ramp discharge type must be entered into the spreadsheet. This can be found on the Ramp Meter Field Inspection Report and should be verified by camera, if possible.

- If the ramp meter has a single lane, then enter “1”
- If the ramp meter has simultaneous discharge, the vehicles are released at the same time, enter “2”
- If the ramp meter has duel discharge, the vehicles are released one at a time, enter “3”

Ramp Volume Determination – The user must enter “1” if there is only one queue loop or if the ramp volume is determined by averaging the

queue loops. The user must enter “2” if the ramp volume is determined by summing the queue loops. Refer to Section 2.1 for further details regarding ramp volume determination.

FIGURE 1
USER DEFINED GENERAL DATA INPUT

User Defined General Data Input		
Note: This sheet is designed to allow the user to input all the necessary data required in one place.		
Data entry fields are indicated by a gray shaded area.		
Explanation:	Acceptable Values/Example:	Input
General Information:		
Ramp Meter I.D. Number	RM 60	
Ramp Meter Location	I43 SB at Capitol Drive	
Purpose of Ramp Meter retiming:		
Is the ramp meter being retimed for general purposes or for use during construction?	Use G or C only.	G
Freeway Information:		
Number of freeway lanes (one direction)	Use 2, 3 or 4 only.	
Peak Hour Factor	Default = .95 (Value range .80 to .99)	0.95
Percent (%) trucks	Default = .06 (Value range .03 to .10)	0.06
Freeway Terrain	L = Level, R = Rolling, M = Mountainous	
Freeway Posted Speed (Mi/Hr)	Use 50, 55, 65 only.	
Ramp Information:		
Ramp total SOV storage (ft)	This requires plan sheet measurements	
Average vehicle length (ft)	Default = 20 (Value range 18 to 22)	20
Ramp meter discharge type (SOV only)	1 = Single Lane, 2 = Two Lanes Together, 3 = Duel	
Ramp Volume Determination:		
Queue Loop Volumes	1 = average of the queue loops	
	2 = sum of the queue loops	

Enter User Defined Ramp Volume Determination

The ramp volume over time period must manually be determined in this section of the Input worksheet (Figure 2). (The user must scroll to the right in order for this section to be displayed on the computer screen.) The spreadsheet has already calculated the ramp volume based on the merge loop (if applicable), queue loops, and passage loops. The Ramp Volume Plot spreadsheet should be viewed by the user to verify that the ramp volume is valid. At this point the user must advise the program to use the appropriate loops. There are two scenarios – ramps with a merge loop and ramps without a merge loop. Both scenarios are discussed below.

Merge Loop Exists – If the on-ramp has a merge loop, then the volume data for the merge loop should be used for the ramp volume for the entire day.

- The user must copy the merge loop volume data, located in COLUMN Q, to COLUMN V, "Ramp Volume Over Time Period."

Merge Loop Does Not Exist – If the ramp does not have a merge loop, then the queue and passage loop(s) should be used for the ramp volume.

The queue loops are used to calculate ramp volume during non-metering periods, so the user must:

- Copy COLUMN U, "Queue Loop Value" to COLUMN V, "Ramp Volume Over Time Period," during non-metering periods. The non-metering periods can be determined by reviewing the current ramp metering schedule.

The passage loops are used to calculate the ramp volume during metering periods, so the user must:

- Copy COLUMN P, "Total of All Ramp Passage Loops," to COLUMN V, "Ramp Volume Over Time Period," during metering periods. The metering periods can be determined by reviewing the current ramp metering schedule.

Step 2 – Open I70 User Spreadsheet

The 170 User worksheet provides the user with recommended timings and threshold values for all six plans in the AM and PM metering periods (Figure 3). It also provides the user with recommendations for the metering periods based on the volume to capacity (v/c) ratio of the freeway (Figure 4). These values are basic recommendations and do not substitute good engineering practice. Thus, the values must be reviewed by the user and may require adjustments. Furthermore, the timings and thresholds must be reviewed and

approved by WisDOT before being implemented. See Section 3.6 – Ramp Meter Timings Review for further details.

Additional ramp meter thresholds, timings, and schedule information is provided in Section 3.7 – New Timings Entry Into 170 User Interface.

Figure 2
User Defined Ramp Volume Determination

User Defined General Data Input:

Note: Values below are in vehicles per hour (VPH).
Data entry fields are indicated by a gray shaded area.

	COLUMN P	COLUMN Q				COLUMN U	COLUMN V
Time:	Total of all ramp passage loops	Merge Loop	Queue #1	Queue #2	Queue #3	Queue loop value (Automatic)	Ramp volume over time period
0:00	0	0	0	0	0	0	
0:15	0	0	0	0	0	0	
0:30	0	0	0	0	0	0	
0:45	0	0	0	0	0	0	
1:00	0	0	0	0	0	0	
1:15	0	0	0	0	0	0	
1:30	0	0	0	0	0	0	
1:45	0	0	0	0	0	0	
2:00	0	0	0	0	0	0	
2:15	0	0	0	0	0	0	
2:30	0	0	0	0	0	0	
2:45	0	0	0	0	0	0	
3:00	0	0	0	0	0	0	
3:15	0	0	0	0	0	0	
3:30	0	0	0	0	0	0	
3:45	0	0	0	0	0	0	
4:00	0	0	0	0	0	0	
4:15	0	0	0	0	0	0	
4:30	0	0	0	0	0	0	
4:45	0	0	0	0	0	0	
5:00	0	0	0	0	0	0	
5:15	0	0	0	0	0	0	
5:30	0	0	0	0	0	0	
5:45	0	0	0	0	0	0	
6:00	0	0	0	0	0	0	
6:15	0	0	0	0	0	0	
6:30	0	0	0	0	0	0	

FIGURE 3
170 USER WORKSHEET
RAMP METER INTERVAL TIMINGS AND RAMP THRESHOLDS

Ramp Interval Timings

AM Interval Timing

Plan	1	2	3	4	5	6
Green	2.0	2.5	2.5	2.5	2.5	2.5
Yellow						
Red	1.8	2.5	3.5	5.0	7.0	9.0
Red Ext.						

PM Interval Timing

Plan	1	2	3	4	5	6
Green	2.0	2.5	2.5	2.5	2.5	2.5
Yellow						
Red	1.8	2.5	3.5	5.0	7.0	9.0
Red Ext.						

Ramp Thresholds

AM Thresholds

Plan	1	2	3	4	5	6
Volume	1200	1400	1600	1800	2000	2200
Occupancy	8	10	12	14	16	18
Veh. Speed	60	55	50	45	40	35
Queue Occ.	60	55	50	40	30	20

PM Thresholds

Plan	1	2	3	4	5	6
Volume	1000	1200	1400	1600	1800	2000
Occupancy	6	8	10	12	16	18
Veh. Speed	60	55	50	45	40	35
Queue Occ.	60	55	50	40	30	20

FIGURE 4
170 USER WORKSHEET
RAMP TIME OF DAY SCHEDULES

RAMP Time Of Day Schedules

Time	V/C >.65	Function	Time	V/C >.65	Function	Time	V/C >.65	Function
5:00	---	7	10:00	---	7	15:00	0.74	11
5:15	---	7	10:15	---	7	15:15	0.80	11
5:30	---	7	10:30	---	7	15:30	0.80	11
5:45	---	7	10:45	---	7	15:45	0.82	11
6:00	---	7	11:00	---	7	16:00	0.81	11
6:15	---	7	11:15	---	7	16:15	0.86	11
6:30	0.67	10	11:30	---	7	16:30	0.88	11
6:45	0.74	11	11:45	---	7	16:45	0.89	11
7:00	0.72	11	12:00	---	7	17:00	0.84	11
7:15	0.78	11	12:15	---	7	17:15	0.80	11
7:30	0.83	11	12:30	---	7	17:30	0.74	11
7:45	0.84	11	12:45	---	7	17:45	0.68	10
8:00	0.77	11	13:00	---	7	18:00	---	7
8:15	0.71	11	13:15	---	7	18:15	---	7
8:30	0.68	10	13:30	---	7	18:30	---	7
8:45	---	7	13:45	---	7	18:45	---	7
9:00	---	7	14:00	---	7	19:00	---	7
9:15	---	7	14:15	---	7	19:15	---	7
9:30	---	7	14:30	0.68	10	19:30	---	7
9:45	---	7	14:45	0.73	11	19:45	---	7

Print Outs

The user should print the following sheets from the Ramp Meter Retiming spreadsheet and place them in the RM folder:

- Retime
- Input
- 170 User
- Mainline V vs. C Plot
- Mainline Average Occupancy Plot
- Ramp Volume Plot
- Mainline Speed Plot

Section 3.6 – Ramp Meter Settings Review and Acceptance

General
Once the new ramp meter settings have been developed, the user must submit them to the person responsible for ramp meter operations. The ramp meter operations engineer will do the following:

1) Review the settings and make any necessary revisions.

   A) Field Inspection Report – Ensure that the Field Inspection Report has been completed and reviewed. Make certain that the appropriate action has been taken to correct any reported problems.

   B) Data Extractor Input Sheet – Check that that the user entered the correct information into the input sheet.

   C) Data Extractor Output Sheet – Review the suggested timing plans, thresholds, and schedule provided by the Data Extractor.

      a. Compare the Data Extractor Output Sheet to the recommendations submitted by the person doing the retiming. Ensure that the recommended settings are appropriate and make necessary revisions in red pen.

      b. Compare the recommended settings to the current settings to ensure that changes are justified and will not cause problems. (i.e. If the ramp tends to back-up easily, the user must be cautious when increasing the red times.)

   A) Corridor Review – Review the ramp meter start/stop times on a corridor basis. Ensure that recommendations are appropriate for the entire corridor. Consider bottleneck conditions, ramp diversion possibilities, etc.

1) Fill out a RM Settings Recommendations Form for each retimed ramp meter. The form summarizes the proposed changes to the current settings. It is saved as *W:\RM's\Ramp Meter Retiming\RM Settings Recommendations Form* and is included in Appendix H. The user can also refer to the Ramp Metering Policies Manual for detailed information regarding ramp metering justification.

2) Conduct a ramp meter settings review and acceptance meeting with WisDOT. The following people should attend the meeting (at a minimum):

- Freeway Operations Supervisor
- Freeway Operations – Operations Project Manager
- AM and PM Lead Operators
- Reviewing Engineer

The meeting allows TOC staff to review, modify, and approve the recommended settings. The meeting should be limited to 30 to 45 minutes in length and should focus on key ramp metering topics like metering start/stop times, coordination considerations, special cases, etc.

1) All ramp meter setting modifications established in the review and acceptance meeting should be marked in green on the settings recommendations form. The final settings are then given to the operator for entry into the 170 User Interface.

Section 3.7 – New Timings Entry Into 170 User Interface

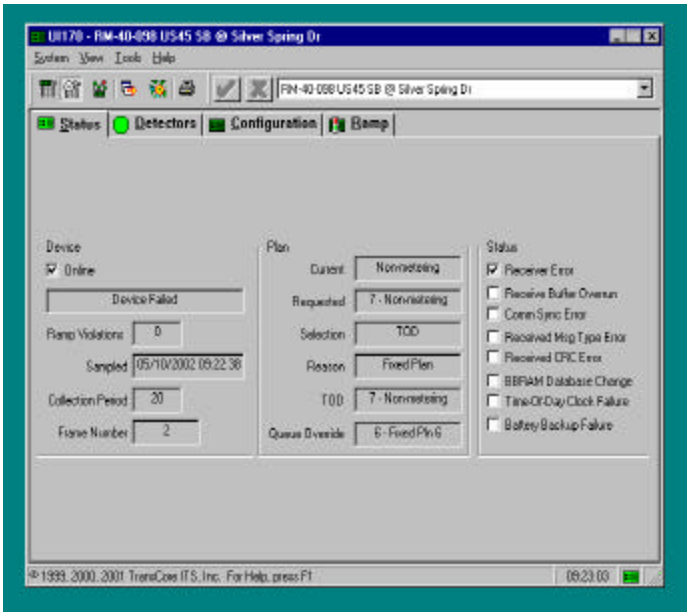
General

After the new ramp meter timings have been reviewed and approved, they should be entered into WisDOT's 170 User Interface program and downloaded to the controller. The 170 User Interface program is available on the computers in the control room. Thus, the user will need a MONITOR ID and password.

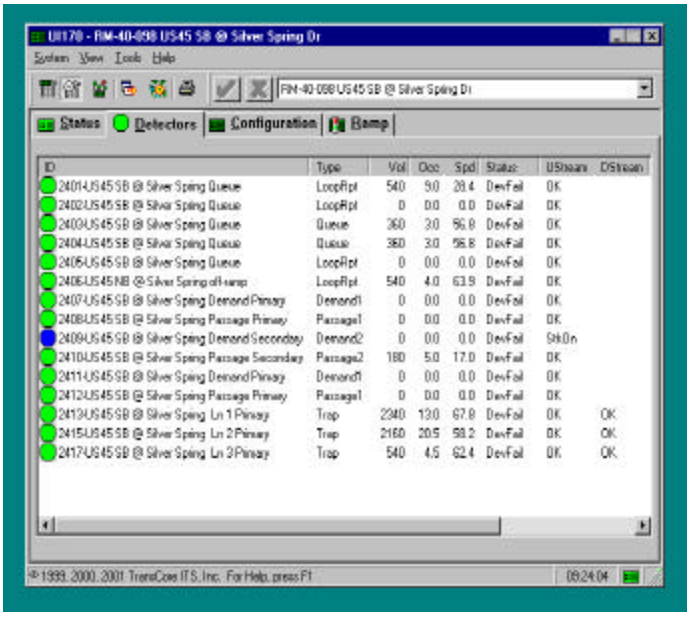
170 User Interface

The user must click on the 170 icon to open the program. The 170 User Interface is comprised of 4 tabs – Status, Detectors, Configuration, and Ramp.

Status Tab – The Status screen, which is shown below, provides information regarding the controller and ramp metering status. This screen is often used when observing ramp meter operations.



Detectors Tab – The Detectors screen, which is shown on the following page, provides information regarding the ramp and mainline detector status. If the user finds failed detectors, then the equipment malfunction procedure should be followed. The procedure is included in Appendix D.



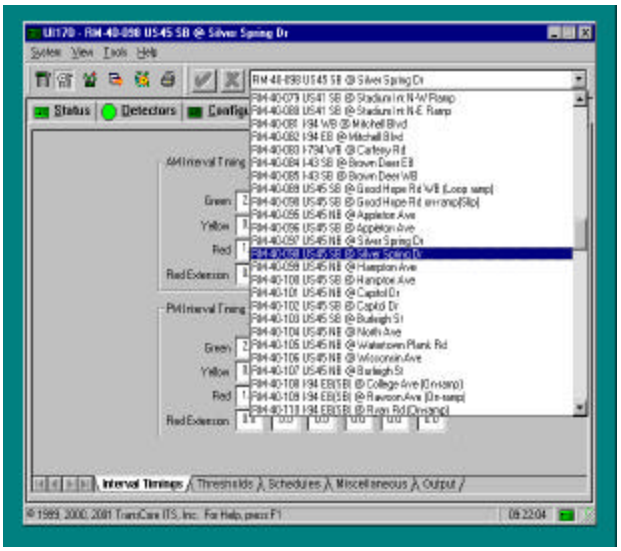
Configuration Tab – The Configuration screen, which is shown on page 37, provides information regarding the configuration of the ramp meter and controller.

Ramp Tab – The Ramp screen, which is shown on page 38, is the gateway to the user interface for ramp meter retiming.

170 User Interface Entry Procedure – The user must manually enter the new timings and metering schedule into the 170 User Interface. The procedure for data entry is as follows:

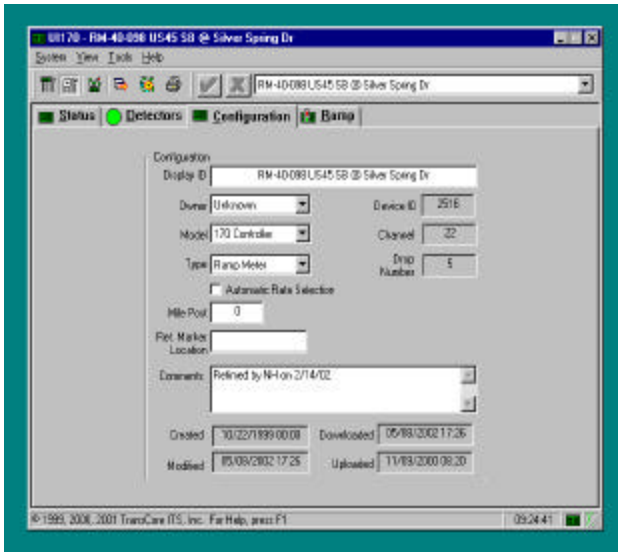
1) Select ramp meter from pull-down menu

The user must select the ramp meter from the pull-down menu as shown on the following page:



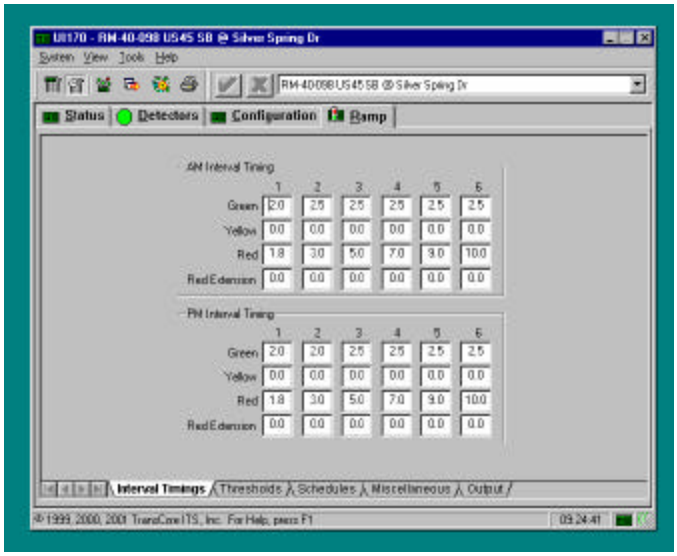
2) Open the Configuration Tab

After the ramp meter is selected, the user must use the comments section in the configuration window to note that the ramp meter was modified. The user should document his or her initials and the date of modification as shown on the following page:



3) Open the Ramp Tab

There are 5 sheets listed along the bottom of the Ramp window, as shown on the following page. They include Interval Timings, Thresholds, Schedules, Miscellaneous, and Output. Each sheet is described in the following pages.



Interval Timings Sheet – The user enters the new ramp meter timings in the Interval Timings interface. This screen is shown above.

Green Time – The green time is typically set to 2.0 seconds for plan 1 and 2.5 seconds for plans 2 through 6.

Yellow Time – The yellow time is always set to 0 seconds, unless it is desirable to set the ramp meter to cycle. It is desirable to set the ramp meter to cycle with red, yellow, and green signals under certain construction scenarios or when the ramp meter is malfunctioning. However, this should only be done under the direction of the ramp meter operations engineer.

Red Time – The red time is set to a minimum value for plan 1. The minimum values are described below:

Minimum Red Times –

- Duel Discharge = 1.8 seconds
- Simultaneous Discharge or Single Lane = 2.5 seconds

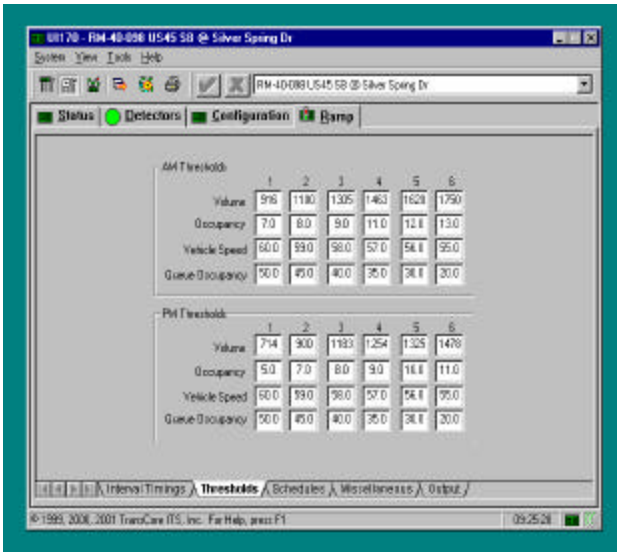
The red time for plan 6 varies per ramp. However, the following are maximum values that should be used.

Maximum Red Times –

- Duel Discharge = 8 seconds
- Simultaneous Discharge or Single Lane = 10 seconds

The red time calculations are automated through the ramp meter retiming excel spreadsheet and entered for each of the 6 plans.

Thresholds Sheet – The user enters the ramp meter thresholds in the Thresholds interface. The volume, occupancy, speed, and queue occupancy thresholds are predetermined from the ramp meter retiming spreadsheet and are entered for each of the 6 plans, as shown below.



Schedules Sheet – The user enters the Time Of Day (TOD) and Holiday schedules in the Schedules interface, which is shown on the following page.

The Holiday schedules are updated on an annual basis, between January 2nd and January 15th, by the control room operations staff. Therefore, modifications to the Holiday scheduler are not necessary, but the dates should be verified for accuracy.

The TOD schedules are developed during the ramp meter retiming process. The user must enter the metering periods as military time, must select the desired ramp metering function (i.e. non-metering,

must/may, or metering), and select the applicable days for the specific function. The user should refer to the Ramp Metering and Detector Station Field Equipment Software manual, Section 1.4.2 for detailed information on the various ramp metering functions (or plan selection types). The following are ramp metering functions that are most often used in ramp metering:

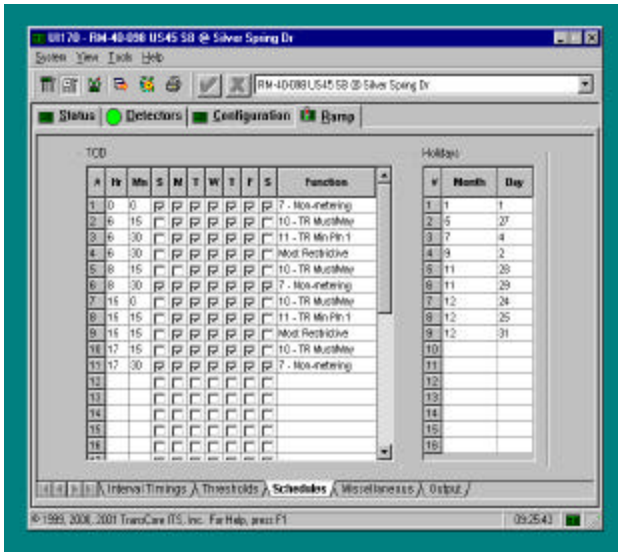
Non-metering – This function is coded as 7 in the 170 user interface.

Must/May – For traffic responsive metering, this function is coded as 10 in the 170 user interface.

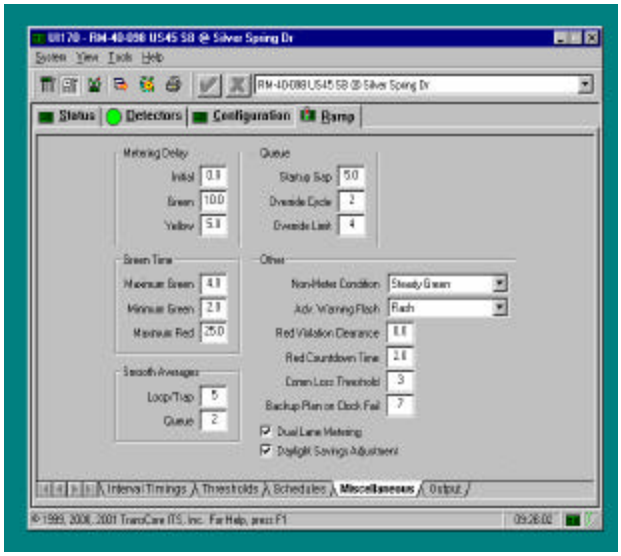
Traffic Responsive Metering – Traffic responsive metering is coded as 11 through 16. The second digit refers to the minimum plan that the ramp can meter in. Function 11 is always used so that the meter has the ability to meter in all plans.

When operating the ramp meter in traffic responsive metering, the user must also select the ramp metering mode. The controller can select the most restrictive or least restrictive metering plan based on the freeway volume, speed, and occupancy, or the plan selection can be based solely on the volume, speed, or occupancy. The current strategy is to select the most restrictive metering plan, so the user should select “Most Restrictive” from the pull-down menu.

Fixed Plan Metering – Fixed plan metering is coded as 1 through 6. When a fixed ramp metering plan is selected, the ramp will meter in that plan regardless of freeway conditions. As previously stated in Section 2.1, ramp meters should not meter in a fixed plan unless mainline loops do not exist or are malfunctioning.



Miscellaneous Sheet – The correct ramp meter parameters should be displayed on the Miscellaneous screen, which is shown below.



The user should verify that the following parameters. (Refer to the Ramp Metering and Detector Station Field Equipment Software Manual for definitions of the parameters.)

Metering Delay

- Initial = 0.0 seconds
- Green = 10.0 seconds
- Yellow = 5.0 seconds

Green Time

- Maximum Green = 4.0 seconds

- Minimum Green = 2.0 seconds
- Maximum Red = 25.0 seconds

Smooth Averages

- Loop/Trap = 5
- Queue = 2 or 3

Queue

- Startup Gap = 5.0 seconds
- Override Cycle = 1 or 2
- Override Limit = 5

Other

- Non-Meter Condition = Steady Green
- Adv. Warning Flash = Flash (for a majority of the ramp meters)

  The following is a list of ramp meters that require this parameter to be set to “Steady” :

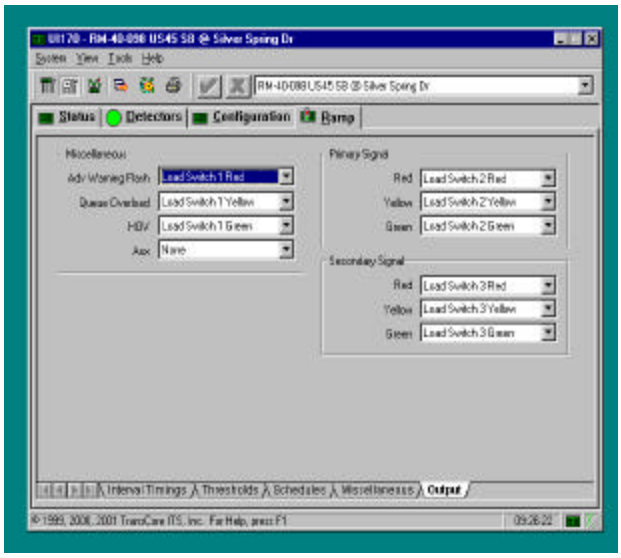
  RM 77 – Stadium Interchange (S-E ramp)
  RM 78 – Stadium Interchange (S-W ramp)
  RM 79 – Stadium Interchange (N-W ramp)
  RM 80 – Stadium Interchange (N-E ramp)
  RM 39 – I-894 NB @ Greenfield Avenue
  RM 21 – I-94 EB @ Hwy 100
  RM 24 – US-45 SB @ Wisconsin Avenue
  RM 10 – I-94 WB @ 84th Street
  RM 89 – US-45 SB @ Good Hope Road
  RM 74 – Airport Spur

  There may be additional ramp meters that require this parameter to be set to “steady”, so the user must always consult with the ramp meter operations engineer, prior to changing this parameter.

- Red Violation Clearance = 0.0 seconds
- Red Countdown Time = 2.0 seconds
- Comm Loss Threshold = 3

- Backup Plan on Clock Fail = 7
- Dual Lane Metering – Check if ramp has dual or staggered discharge
- Daylight Savings Adjustment – Check box

Output Sheet– The Output user interface is shown below, but should not be adjusted by the user.

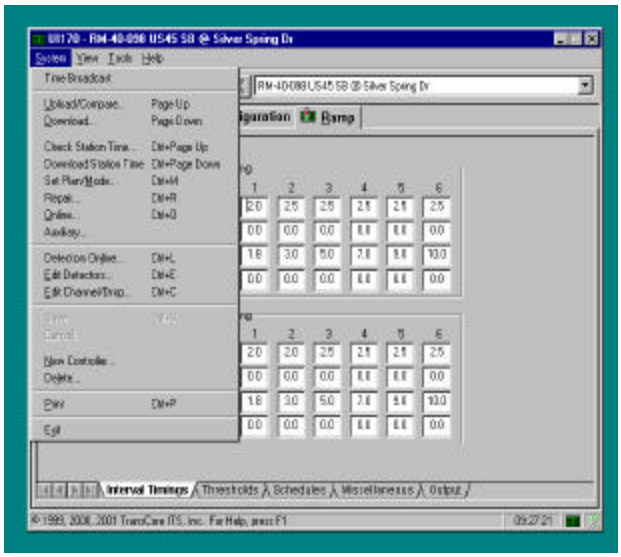


4) Save Changes to 170 User Interface

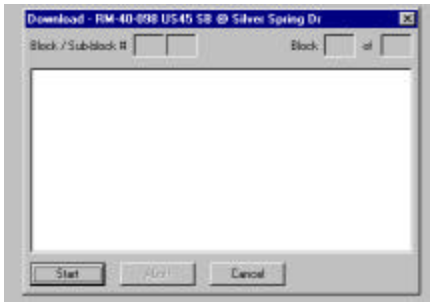
The user must save changes to the 170 by clicking on the green check mark at the top of the page. The red X can be selected if the user does not want to save the changes.

5) Download Timings Into Controller

The user must download the new timings by selecting System from the pull-down menu, and then selecting Download.



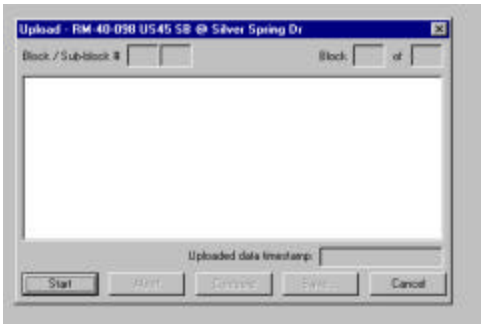
The following screen will appear:



The user must click the Start button for the download to begin. A message will appear on the screen when the download is complete. The user must then select the Cancel button to remove the Download interface from the screen.

6) Upload and Compare Timings

The user must upload the data from the controller and compare it to the timings in the 170 User Interface. This is done to ensure that the download process was successful. This is done by selecting System from the pull-down menu, and selecting Upload/Compare. The following screen will appear:



The user must click the Start button to begin the upload process. A message will appear in the window when the upload is complete, and then the user must select the Compare button. The user should scroll through the document to verify that the data in the controller and at MONITOR are consistent. Data highlighted in yellow indicates an inconsistency and should be modified by the user. Assistance from the Operations Engineer may be necessary if problems persist. When the process is complete, the Cancel button must be selected to remove the interface from the screen.

7) Check Station Time

The user must verify that the station time is accurate. The station time is checked by selecting Check Station Time from the System pull-down menu. The user must then press the “Get” button for the process to proceed. The date and time for MONITOR and the controller will appear in the window. If they are not consistent, then the user must download the correct date and time to controller.

8) Download Station Time (If Station Time Is Incorrect)

If the station time is not accurate, the time must be downloaded by selecting Download Station Time from the System pull-down menu. The time should be checked again, by following the procedure described above, to verify that download was successful.

9) Print Ramp Meter Timing Sheets

The user must print the sheets from the 170 User Program by selecting Print from the System pull-down menu. The timing sheets must be filed in the appropriate RM folder after the retiming process is complete.

10) Close 170 User Interface

Once the new timings have been printed, the user can repeat the process for additional ramp meters, or can close the 170 User Interface by selecting Exit from the System pull-down menu.

Section 3.8 – Ramp Meter Observation

General

The user must observe the ramp meter for a minimum of 30 minutes, after the new timings are downloaded, to ensure proper metering. The user must complete the Ramp Meter Retiming Field Review form. The form can be found at *W:\RM's\Ramp Meter Retiming\RM Retiming Field Review* and is included in Appendix F.

Ramp Meter Retiming Field Review Form

The Ramp Meter Retiming Field Review Form is comprised of 3 main sections – Ramp Conditions, Freeway Conditions, and Recommendations for Improvement. The content of each of the 3 sections is described in the following pages.

Ramp Conditions

The user should note whether the ramp began metering during the must/may period or during the scheduled metering time. If the ramp meter does not turn on, the Equipment Malfunction Procedure should be followed in order to report the problem. The Equipment Malfunction Procedure is included in Appendix D.

The user should also check that the vehicles are properly activating the ramp meter when stopped at the stop bar. If vehicles are not receiving the green indication properly, the problem should be explained and the Equipment Malfunction Procedure should be followed.

The user should document if the ramp meter is discharging vehicles appropriately for the given freeway volume and speed. If the ramp is not discharging the vehicles appropriately, then the user should note whether the meter is discharging vehicles too fast or too slow. The timings must then be adjusted so the meter is discharging vehicles appropriately.

The user must also note the vehicle queue length on the ramp. If the vehicles are spilling onto the side street, then the timings should be adjusted to prevent it from happening.

The user should also check to see that the ramp meter is not cycling. A ramp meter is cycling when the signals change from red to green continuously, even if a vehicle is not present at the stop bar. If the ramp is cycling, the Equipment Malfunction Procedure should be followed.

Freeway Conditions

The user should document the approximate volume of the freeway as light, moderate, or congested. The user should also provide the estimated freeway speed. The approximate speed can be determined when driving to/from the ramp.

Recommendations for Improvement

The user should document any recommendations for improvement. This may include adjustments to the signal timings or thresholds. These improvements should then be implemented and further ramp meter observation must take place.

Reviewed By

The ramp meter operations engineer should review the form to ensure that the ramp was observed after the new timings were implemented. If further action is taken, it should be noted in the section provided on the review form.

Further Ramp Meter Observation

If the ramp meter requires timings or threshold adjustments, or if the ramp requires maintenance, the user must observe the ramp meter again after all adjustments and repairs are made. A second observation form must also be completed to verify that the meter is operating effectively.

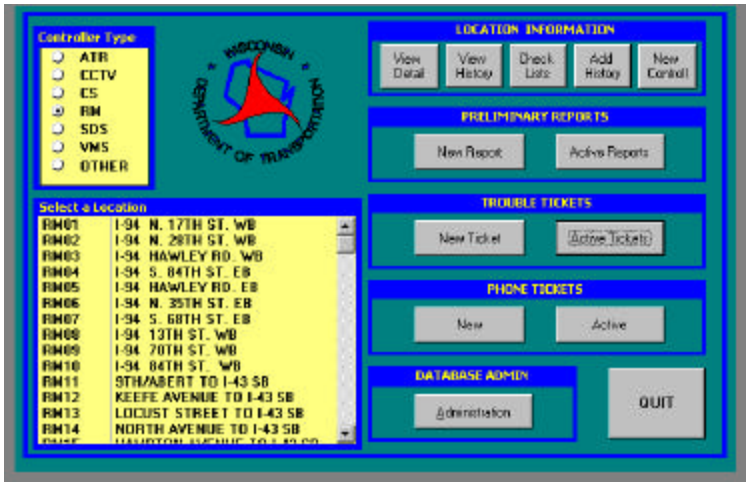
Section 3.9 – Documentation and Filing Documents

General

It is necessary to record all changes made to ramp meter timings in the MONITOR maintenance log and to file documentation for ramp meter retiming properly.

Maintenance Log – Electronic Files

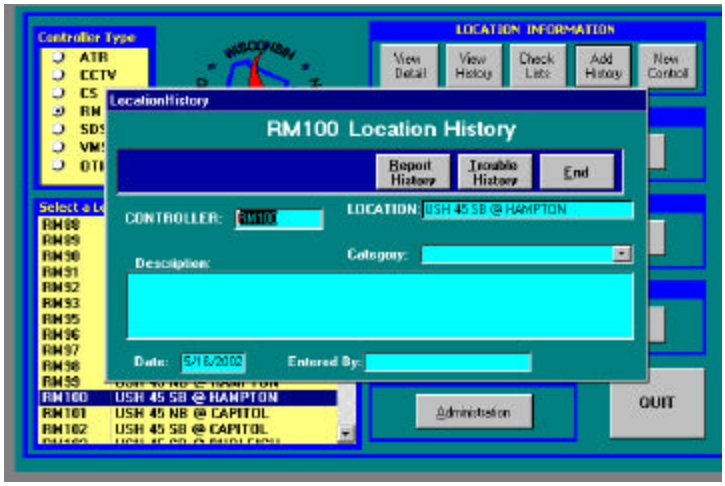
The maintenance log is located on the MONITOR system in the control room. The program is utilized to track maintenance problems and changes to FTMS equipment. The user opens the program by clicking on the "Shortcut to Maintenance" icon located on the desktop of all computers in the control room. The following user interface will appear:



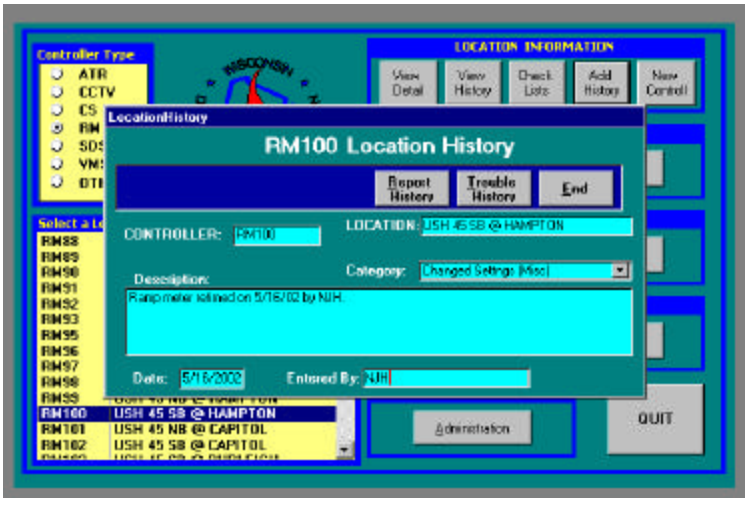
When recording changes to the setting of a ramp meter, the following steps should be taken:

1) Select the ramp meter from the "Select a Location" menu on the left of the screen.
2) Click the "Add History" button from the "Location Information" menu at the top right corner of the screen.

The following screen will appear:



3) Select “Changed Settings (Misc)” from the “Category” pull-down menu.
4) Use the description box to indicate that the ramp meter was retimed.
5) Enter your initials in the “Entered By” box.
6) Click the “End” button. (Your changes will be saved automatically.)



Filing Ramp Meter Retiming Documentation – Paper Files

All documentation for the ramp meter retiming must be filed in the ramp meter folder. The following is a list of items that should be filed:

- Ramp Meter Field Inspection Report
- Print outs from Data Extractor spreadsheet
- Print out of new timings from 170 User Interface
- Ramp meter retiming Field Review Form
- Ramp Meter Recommendations Form

All of the documents from the previous retiming efforts should be relocated to the folder for “previous timings.”

Section 4 – Ramp Meter Retiming Process Checklist

Section 4.1 – Purpose

The Ramp Meter Retiming Process Checklist, which is included in Appendix G, is to be filled out by the user during the retiming process. The form is saved as *W:\RM's\Ramp Meter Retiming\RM Retiming Process Checklist* and should be printed out prior to beginning the ramp meter retiming process.

The checklist guides the user through the main steps in ramp meter retiming. As each item is checked off, it also confirms that the user completed each step. The checklist is submitted, along with the other ramp meter materials to be reviewed, to the current staff member responsible for ramp meter operations.

Section 5 – Summary

Section 5.1 – Summary

The Ramp Meter Retiming Procedure is intended to assist engineers and operators with retiming ramp meters along the Milwaukee freeway system. By following this procedure, the Department will be assured that proper ramp meter retiming has been done.

The manual is considered a “living” document and will require modifications as the ramp meter retiming process is refined, amended, or changed. Therefore, the Department should consider reviewing and modifying the document once a year, or as changes in procedure arise.

If ramp meters are retimed on an annual basis, the Milwaukee freeway system will experience a reduction in accidents, less congestion, and predictable travel times.

MONITOR Control Room Support Contract

Ramp Meter Retiming Procedure

Appendices

Appendix A

2002 – 2003 Ramp Meter Retiming Schedule

MONITOR

2002-2003 Ramp Meter Retiming Schedule

Updated on 9/16/02

Priority #	Sub-Cooridor Location	Number of Ramps	Original Due Date	Completion Date
1	US 45 SB	(14 ramps)	1-Dec-02	11-Dec-02
2	US 45 NB	(10 ramps)	1-Jan-03	8-Jan-03
3	I-94 EB from the Zoo Interchange to the Marquette Interchange	(8 ramps)	1-Feb-03	7-Feb-03
4	I-94 WB from the Marquette Interchange to the Zoo Interchange (including I-794 WB)	(11 ramps)	1-Mar-03	
5	I-94 EB from CTH J to the Zoo Interchange	(7 ramps)	1-Apr-03	
6	I-94 WB from the Zoo Interchange to CTH G	(6 ramps)	1-Apr-03	
7	I-94 NB from Ryan Road to the Mitchell Interchange	(6 ramps)	1-May-03	
8	I-94 SB from the Mitchell Interchange to Ryan Road	(4 ramps)	1-May-03	
9	I-43 NB from the Marquette Interchange to Locust Street	(3 ramps)	1-May-03	
10	I-43 SB from Mequon Road to the Marquette Interchange	(12 ramps)	1-Jun-03	
11	I-43/94 NB from the Mitchell Interchange to the Marquette Interchange	(5 ramps)	1-Jul-02	
12	I-43/94 SB from the Marquette Interchange to the Mitchell Interchange	(5 ramps)	1-Jul-03	
13	I-894 NB from the the Hale Interchange to the Zoo Interchange	(6 ramps)	1-Aug-03	
14	I-894 SB from the Zoo Interchange to the Hale Interchange	(3 ramps)	1-Aug-03	
15	I-894 EB from the Hale Interchange to the Mitchell Interchange (including I-43 EB)	(6 ramps)	To Be Completed After Construction	
16	I-894 WB from the Mitchell Interchange to the Hale Interchange	(5 ramps)	To Be Completed After Construction	

2002-2003 Ramp Meter Retiming Schedule

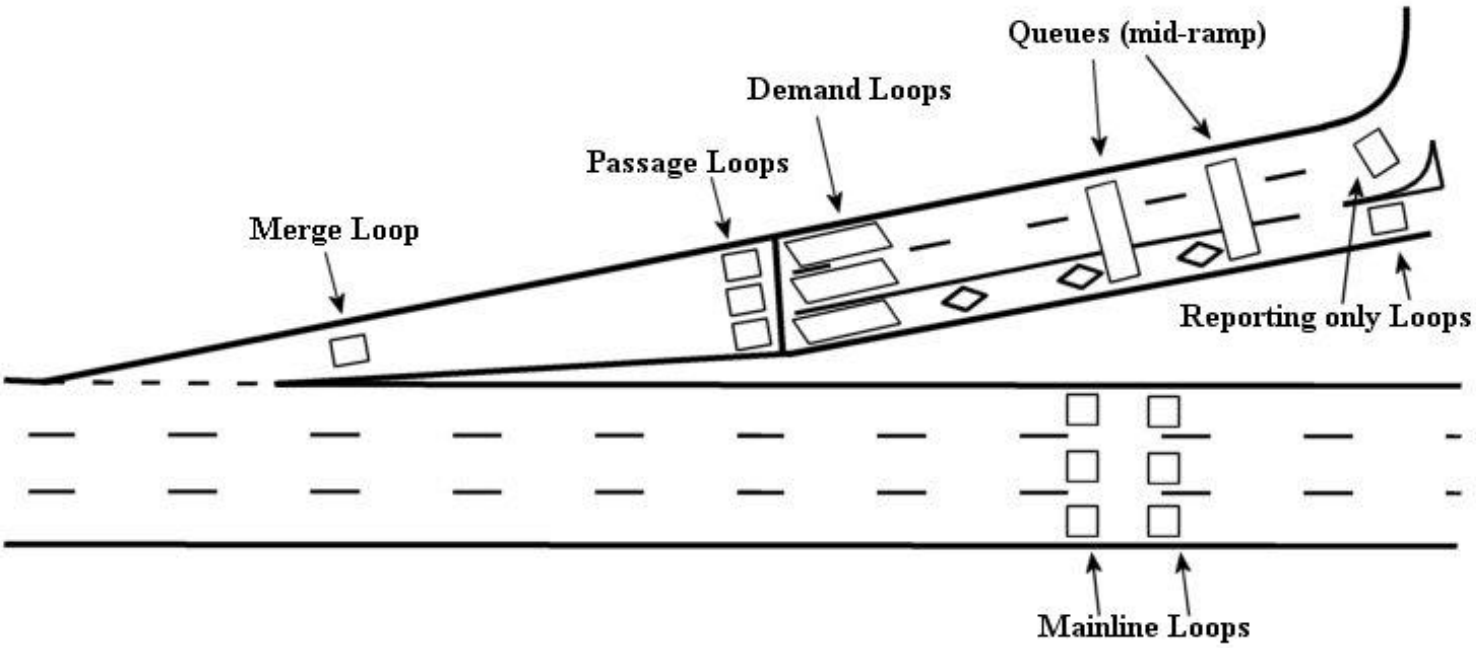
Updated on 9/16/02

Priority #	1-Nov	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	
	Month									
1	10 Ramps	(US-45 NB)								
2	----------	14 Ramps	(US-45 SB)							
3	----------	----------	8 Ramps	(I-94 EB from the Zoo to Marquette)						
4	----------	----------	----------	11 Ramps	(I-94 WB from the Marquette to the Zoo)					
5	----------	----------	----------	----------	7 Ramps	(I-94 EB from CTH J to the Zoo)				
6	----------	----------	----------	----------	6 Ramps	(I-94 WB from the Zoo to CTH G)				
7	----------	----------	----------	----------	----------	6 Ramps	(I-94 NB)			
8	----------	----------	----------	----------	----------	4 Ramps	(I-94 SB)			
9	----------	----------	----------	----------	----------	3 Ramps	(I-43 NB)			
10	----------	----------	----------	----------	----------	----------	12 Ramps	(I-43 SB)		
11	----------	----------	----------	----------	----------	----------	----------	5 Ramps	(I-43/94 NB)	
12	----------	----------	----------	----------	----------	----------	----------	5 Ramps	(I-43/94 SB)	
13	----------	----------	----------	----------	----------	----------	----------	----------	6 Ramps	(I-894 NB)
14	----------	----------	----------	----------	----------	----------	----------	----------	3 Ramps	(I-894 SB)
15	----------	----------	----------	----------	----------	----------	----------	----------	----------	6 ramps (I-894 EB) To Be Completed After Construction
16	----------	----------	----------	----------	----------	----------	----------	----------	----------	5 ramps (I-894 WB) To Be Completed After Construction

Appendix B

Loop Detector Diagram

Loop Detector Diagram



Appendix C

Ramp Meter Field Inspection Report

Ramp Meter Field Inspection Report

(Observe for a **minimum of 15 minutes** during ramp metering period.)

RM # _____ Location_____

Date _____ Time _____ Observed by _____

Weather Conditions _____ Pavement Conditions _____

Ramp Meter (General Information)

A. Configuration:

Number of SOV lanes _____

Is There An HOV lane: Yes • No •

B. Discharge:

SOV Lanes: Staggered • Lanes Released together • N/A (Single Lane) •

HOV Lane: N/A • Steady Green • Discharge with Adjacent lane •

Discharge with Far lane Discharge Alone

Excessive HOV Violations: Yes △ No

Comments – Required When △ is checked:

_____

_____

_____

C. Ramp and Freeway Conditions:

Observed During Normal Metering Period

Queue Length: 0-3 Cars ½ Ramp ¾ Ramp Full △ Spilling into Arterial △

Freeway Average Speed: 0-20 mph 20-40 mph 40-60 mph

Freeway Average Volume: Light Moderate Congested

Comments – Required When △ is checked:

_____

_____

_____

Signing (Compare to Plans)

A. "Ramp Metered When Flashing" Signs:

Number of Signs (per plans) _____

Signs Missing: No Yes △

Condition of Signs: Good Damaged △ Turned △ Obstructed △

Comments – Required When △ is checked:

_____

_____

_____

B. "Stop Here On Red" Signs:

Number of Signs (per plans) _____

Signs Missing? No Yes △

Condition of Signs: Good Damaged △ Turned △ Obstructed △

Comments – Required When △ is checked:

_____

_____

_____

C. Lane Designation Signs:

Right Lane: N/A Good Missing △ Damaged △ Turned △ Obstructed △

Center Lane: N/A Good Missing △ Damaged △ Turned △ Obstructed △

Left Lane: N/A Good Missing △ Damaged △ Turned △ Obstructed △

Comments – Required When △ is checked:

_____

_____

_____

D. HOV Signs:

N/A

Signs on Ramp:

Number of Signs (per plans) _____

Signs Missing? No Yes △

Condition of Signs: Good Damaged △ Turned △ Obstructed △

Comments – Required When △ is checked:

_____

_____

_____

Signs on Side Streets:

Number of Signs (per plans) _____

Signs Missing? No Yes △

Condition of Signs: Good Damaged △ Turned △ Obstructed △

Comments – Required When △ is checked:

_____

_____

_____

Pavement Markings (Compare to Plans)

A. Pavement Markings:

Stop Bar: Present Missing △

Condition: Good Faded △

Edge lines: Present Missing △

Condition: Good Faded △

Lane Skips: N/A Present Missing △

Condition: Good Faded △

Median Paint: N/A Present Missing △

Condition: Good Faded △

HOV symbols: N/A Present Missing △

Condition: Good Faded △

B. Comments – Required When △ is checked:

_____

_____

_____

Pavement Condition

A. Pavement Type: Concrete Asphalt

B. Pavement Condition: New Good Fair △ Poor △

Comments – Required When △ is checked:

_____

_____

_____

C. Pavement Condition In Areas Of Loop Detectors:

Cannot identify where detector loops are located

Pavement is depressed in loop slots △

Cracks or deterioration in pavement around loops △

Comments – Required When △ is checked:

_____

_____

_____

Hardware

A. Signal Heads:

Red (upper heads): Working Not working △

Red (lower heads): Working Not working △

Yellow (upper heads) : Working Not working △ Not inspected △

Green (upper heads): Working Not working △

Green (lower heads): Working Not working △

Enforcement Signal: N/A Working Not working △

B. Advanced Flashes: Working Not working △

C. Comments – Required When △ is checked:

_____

_____

_____

Cabinet

A. Exterior Condition: Good Fair Needs work △

B. Is The Lock Easily Accessible: Yes No △

C. Maintenance Around Cabinet (grass, weeds, etc.): Good Needs Work △

D. Water In Or Around Cabinet: Yes △ No

E. Interior Condition:

Lights: Working Not Working △

Is the controller in watchdog failure(WDT Fail): Yes △ No

MU toggle switch: On Off/Reset

Are any circuit breakers in "off" position: Yes △ No

Are there any signs of pests (bugs, mice etc.): Yes △ No

Are any of the detector amplifiers pulled out: Yes △ No

Are any of the detectors in failure: Yes △ No

F. Comments – Required When △ is checked:

_____

_____

_____

Action Taken:

_____

_____

_____

_____

****

This Section To Be Completed By Person Responsible For Ramp Meter Operations

Reviewed By: _____ Date: _____

- Created ticket or preliminary report for:

_____

_____

_____

_____

Further Action Taken:

_____

_____

_____

_____

Appendix D

Equipment Malfunction Procedures

Equipment Malfunction Procedures

If an operator or staff member is aware of a system field component malfunctioning they should check the maintenance database under reports or tickets to verify if the trouble has been reported. If there is no open ticket or report for the device the operator should create a new report using the following procedure;

- Select the Controller Type, for an entire communications channel or type not listed choose Other
- Choose the correct location from the list.
- Click on the "Prelim Report" button (preliminary report form will appear with controller location and date already filled in)
- Put your initials in the Reported By field and describe the problem in the Description field

Tickets should only be generated if instructed by a senior operator or systems unit personnel. When a ticked has been generated and printed it should be placed in the Maintenance in box if it is for the ATMS maintenance contractor (Pieper) or faxed if it is for the VMS maintenance contractor (TAPCO).

Active maintenance tickets can be checked any time by selecting the "Active Tickets" button on the main menu. This will show a list of all uncleared tickets. As field maintenance personnel respond to tickets they will call the control room to provide updates on the status of the ticket. Upon receiving a call from the field the operator should open the ticket from the Active Tickets list and update the status of the ticket in the "Action Taken" field, all other fields will be filled in by maintenance personnel later.

If a ticket has not been generated yet the operator should make a preliminary report upon receiving a call from the field. Maintenance personnel will make a ticket with all details the next day. A list of active preliminary reports is printed daily in the control and reviewed by maintenance personnel. If a problem still exists a ticket is generated and report is cleared, if no problem is found it is noted and the report is cleared.

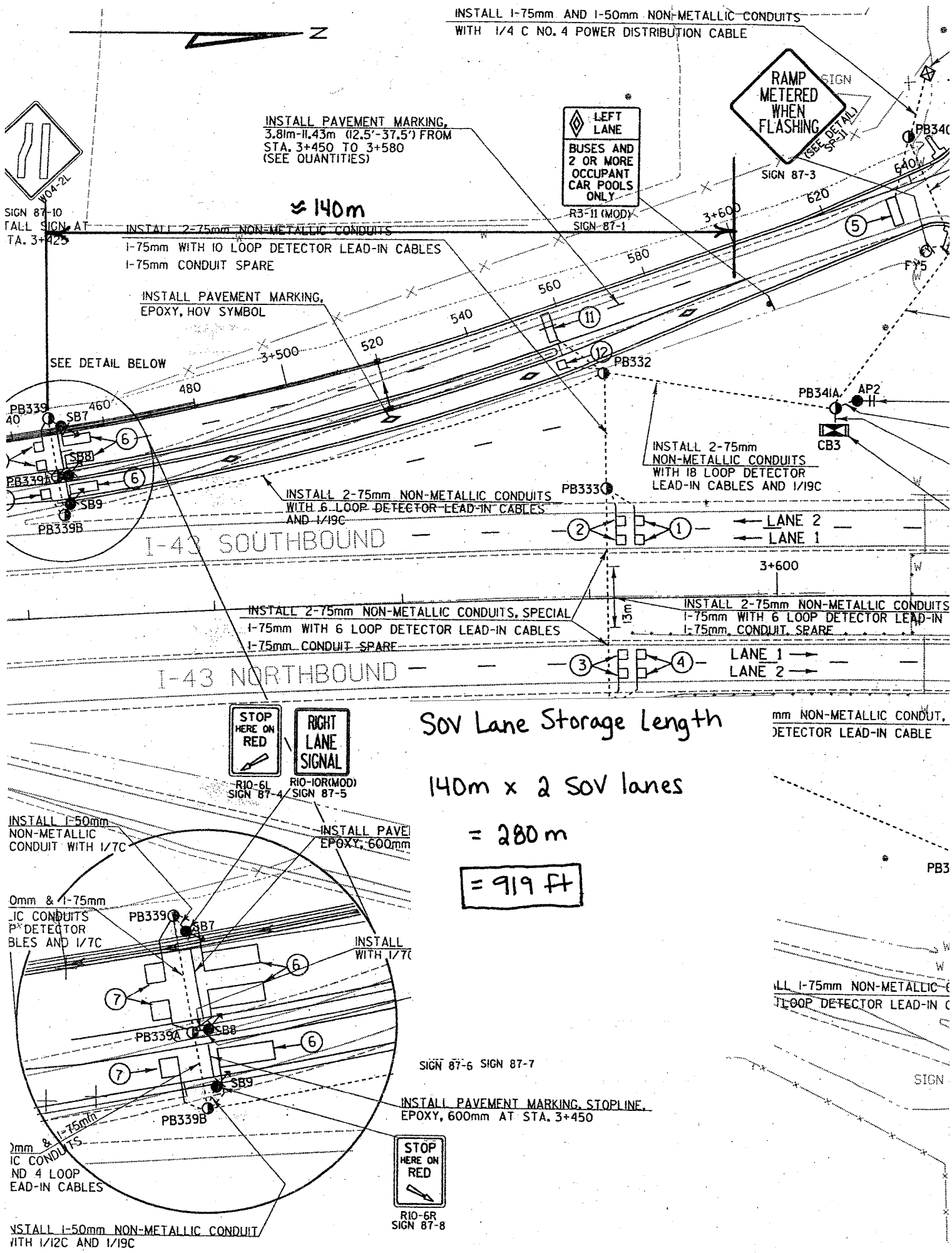
If an operator is required to make changes to ramp meter settings, is notified of a long term outage of any device or has other information related to the operation of any system component that is not a direct maintenance issue, he should log the information as a Location History (settings changes should also be reported to the person responsible for timings). From the main menu select the location you are concerned with, then select the Add History button. On this screen select the appropriate category from the pull down box, write a brief description, modify the date if necessary, and put your initials in the Entered By box. Pressing the End button will save this history entry.

The ATMS maintenance contractor is required to be available 7AM – 4PM. After these hours operators can call the contractor and they will be paid on an hourly basis, or call the state sign shop at 266-1167.

Don Schell - 2001

Appendix E

Ramp Storage Length Measurment



SOV Lane Storage Length

140m x 2 SOV lanes

= 280 m

= 919 ft

Appendix F

Ramp Meter Retiming Review Form

Ramp Meter Retiming Review Form

(Observed ramp for minimum of 30 minutes. Ramp can be observed in the field or via cameras if possible.)

RM # _____ Location _____ Direction _____

Date _____ Time _____ Observed by _____

Weather Conditions _____ Pavement Conditions _____

Ramp Conditions

Did ramp begin metering during must/may period? Yes No

If no, did it begin metering at the scheduled time? Yes No

Do vehicles at the stop bar activate the green indication properly?

SOV Lane: Yes No N/A SOV Lane: Yes No N/A

HOV Lane: Yes No N/A

If no, explain problem.

_____

_____

Is the ramp meter discharging vehicles appropriately for given freeway volume and speed? Yes No

If no, the ramp is discharging vehicles: too fast too slow

What is the ramp queue length: 0-3 cars ½ ramp ¾ ramp ramp full spilling onto side street

Is the ramp meter cycling? Yes No

Freeway Conditions

Freeway volume: Light Moderate Congested

Freeway average speed: 0-20mph 20-40mph 40-60mph

Recommendations for Improvement

_____

_____

****

Reviewed By:_____ Date:_____

Action Taken:_____

_____

Appendix G

Ramp Meter Retiming Process Checklist

Ramp Meter Retiming Process Checklist

This form will guide you through the ramp meter retiming process. Please write your initials in the space provided as each task is completed. After the process has been completed, the RM Operations Engineer must perform a final sign-off and file the checklist in the appropriate RM folder.

_____ Collect RM Background Information

_____ Perform RM Inspection and Fill Out RM Field Inspection Report

_____ Data Collection and Validation with Data Extractor

_____ Input Information Into RM Retiming Spreadsheet and Develop New Settings

_____ Review of New RM Timings by RM Operations Engineer

_____ Fill Out Ramp Meter Recommendations Forms

_____ Hold Review and Acceptance Meeting With WisDOT TOC Staff

_____ Enter New Timings into 170 User Interface and Download to Controller

_____ Observe RM and Complete RM Retiming Review Form

_____ Document Changes to RM in Maintenance Database

_____ File New Settings in RM Folder

_____ Final Review by RM Operations Engineer

Signature Date

Appendix H

Ramp Meter Recommendations Form

RAMP METER RECOMMENDATIONS FORM

Ramp Meter

Timings

☐ No Changes

☐ Increased Red Times

☐ Decreased Red Times

☐ Other _____

Thresholds

☐ No Changes

☐ Modified Based On Current Freeway Conditions

☐ Other _____

AM Schedule

Current Schedule

Recommended Schedule

Recommendations Based on Criteria:

Yes	No				
☐	☐	V/C Ratio	< 0.65	0.65-0.70	> 0.70
☐	☐	Downstream Bottleneck	< 1 Mile	1-2 Miles	> 2 Miles
☐	☐	Speed Reduction	< 10 MPH	10-15 MPH	> 15 MPH
☐	☐	Platooning			
☐	☐	Ramp Diversion			
☐	☐	Observation			
☐	☐	Ramp Acceleration Length			
☐	☐	Ramp Volume			
☐	☐	Other _____			

PM Schedule

Current Schedule

Recommended Schedule

Recommendations Based on Criteria:

Yes	No				
☐	☐	V/C Ratio	< 0.65	0.65-0.70	> 0.70
☐	☐	Downstream Bottleneck	< 1 Mile	1-2 Miles	> 2 Miles
☐	☐	Speed Reduction	< 10 MPH	10-15 MPH	> 15 MPH
☐	☐	Platooning			
☐	☐	Ramp Diversion			
☐	☐	Observation			
☐	☐	Ramp Acceleration Length			
☐	☐	Ramp Volume			
☐	☐	Other_____			

Notes:

Questions: